A. Overview Information

I. Federal Agency Name: Defense Advanced Research Projects Agency, Information Processing Technology Office (DARPA/IPTO)
II. Title: Information Theory for Mobile Ad-Hoc Networks (ITMANET)
III. Announcement Type: Request for Information (RFI)
IV. Solicitation Number: RFI 06-17
V. CFDA Number: 12.910
VI. Key Dates
   a. Position Papers Due: 4:00 PM (ET), March 1, 2006
   b. Workshop Registration: March 1, 2006
   c. Workshop Presentations Due: 4:00 PM (ET), March 1, 2006
   d. Workshop: March 7, 2006

B. Full text of announcement

I. Description

In accordance with FAR 35.007(j), the Information Processing Technology Office (IPTO), Defense Advanced Research Projects Agency (DARPA) requests information on research ideas and approaches that could provide superior theoretical insights to guide the design and deployment of next-generation wireless mobile networks. The requested information is sought to inform an anticipated research program on "Information Theory for Mobile Ad-Hoc Networks" (ITMANET). DARPA currently anticipates that the envisioned program would be funded in the 6.1 budget category at a level of approximately $13,500,000 over five years. DARPA anticipates funding at most two cross-institution teams to conduct this long-term fundamental research. A Broad Agency Announcement and/or other solicitation may be posted later this year. In addition to a conventional solicitation, DARPA anticipates that special arrangements will be made to encourage responses from cross-institution teams of early-career Young Investigators, to be tentatively defined as untenured faculty having completed their PhD less than 5 years prior to the response deadline of the potential solicitation(s).

The first objective of the ITMANET program is to close the open problem concerning the capacity limits of mobile ad-hoc networks (MANETs). A crowning achievement of information theory has been to characterize the upper capacity bounds of an additive Gaussian white-noise channel; similar insight is sought into the limitations of future networks. However, unlike Shannon's source-channel-sink capacity formulation, the desired formulation will take into account not just bandwidth, signal, and noise levels but rather a wider range of dimensions including energy, latency, computation, mobility, traffic characteristics (including bursty and diverse source types), topology, overhead, and node heterogeneity. The desired formulation would characterize constants and bounds both asymptotically and for specific network instances. And finally, unlike present research results which are based on specific technology choices (multihop routing, scheduling with spatial re-use, successive interference cancellation, etc) the desired results would provide technology-independent guidance for future research much as the AWGN capacity formula has provided targets for wireless modulation schemes.

The second program objective is to understand and exploit implications of the newly developed theory. For example, another crowning achievement of present information theory has been the source-channel separation theorem, which has substantial architectural implications. If similar separation theorems can be developed for MANETs, we may be able to discern a theoretically motivated network stack that will be more appropriate for MANETs than present wireline-oriented architectures.

Another category of desirable insight concerns design implications for future network protocols. For instance, researchers are investigating store-carry-forward protocols for disruption-tolerance in mobile networks; researchers are also investigating network coding protocols for capacity improvement. Since both investigations exploit memory at the routing nodes, it is natural to expect that a unified theory of MANET capacity would reveal a deep relationship between these two concepts leading to a unified protocol. As a second example, researchers have suggested technologies such as successive interference cancellation (SIC) that can involve cooperative diffusion of information; network coding may again prove deeply related since practical protocols may involve a similar cooperative diffusion. As a third example, emerging physical smart antenna technologies offer degrees of freedom concerning interference cancellation, MIMO, and beam-forming; the relationship between such choices and specific higher-layer protocols remains an open question that could be informed by information theory. Fourth, it is unclear to what extent hierarchy, heterogeneity, and multi-channel approaches should play into an overall wireless network deployment, and the desired theory may provide new insights for large-scale network design and deployment. Fifth, the concept of "security overlay" needs to be factored into network design, and there may be implications for overlay design that arise from better information theory. This list of desirable design insights is certainly not exhaustive, and even posing the right questions requires deeper insight than is presently available.

In sum, there are many questions that may be addressed as a byproduct of better information theory for mobile wireless networks, but the foundations need to be created first. The hypothesis of this anticipated program is that a specific challenge problem --- better understanding of MANET capacity limits --- will lead to actionable implications.

For purposes of this RFI, the term MANET is not intended to convey conventional limitations such as a focus on flatly routed networks comprising homogeneous nodes. Rather, the term is meant only to suggest the myriad complications arising from future networks incorporating elements of mobility and wireless technology.

To inform the potential program structure and solicitation, DARPA/IPTO is soliciting position papers answering the following questions:

- To what extent is a precise characterization of mobile wireless network capacity achievable?
- How would one recognize a "complete" mobile wireless network capacity limit formulation if one were to see it?

- What is the largest number of problem dimensions (latency, mobility, heterogeneity, etc) for which the responder believes an upper bound on capacity can be understood within the timeframe of a 5-year program?
- What enabling insights have recently emerged that give grounds for optimism? Are there any theoretical breakthroughs or experimental results that suggest promising research directions for the proposed program?
- What are the principal obstacles to developing the desired theory? What intermediate questions need to be answered to achieve the result? Is it possible to lay out a research agenda that marches inexorably toward the proposed objective of capacity understanding, and what might the agenda involve?
- Apart from MANET capacity understanding, what is the most important set of related tractable network-information-theoretic questions that could be addressed within the timespan of the envisioned program? What would be the practical uses of answers to those secondary questions?
- To what extent do results from other fields (e.g. physics) seem to contribute to the desired theory and in what way?

Interested parties should submit their position paper and optional briefing by responding to this RFI as described in Section IV - Application and Submission Information below.

All information contained in the RFI is preliminary, as well as subject to modification, and is in no way binding on the Government. As a result of ideas submitted in response to this RFI, DARPA will acknowledge receipt of the submission, but will not provide feedback. However, DARPA/IPTO might invite selected individuals to present talks, plan and/or conduct invited workshops on relevant topics, etc. Any material not clearly marked as proprietary will be considered to be public information. All submissions may be handled by non-government personnel bound by nondisclosure agreements. This RFI incorporates by reference FAR 52.215-3, "Request for Information or Solicitation for Planning Purposes (OCT 1997)," with the same force and effect as if it were given in full text [reference paragraph (c) of this provision, the "purpose" of this RFI is detailed in this announcement].

WORKSHOP

A workshop will be held for RFI respondents, which will present an overview of the ITMANET program concept, and will include invited presentations, submitter presentations, discussions, and Q&A. If interested in attending, please visit the Registration website at http://csc-ballston.dmeid.org/darpa/registration/intro.asp?regCode=yujjuryE. In order to attend the workshop, attendees must be registered on the site by March 1, 2006 and have submitted an RFI response. Acceptance of registration will be conditional upon receipt of a responsive position paper as well as space limitations. Because of space limitations, participation may be restricted to a single representative of a given institution and/or a single co-author of a given position paper. Non-U.S. citizens may attend pending the completion of the Foreign National Information Request Form found on the registration site. Attendance at the workshop is voluntary. Attendance is not required to propose to subsequent Broad Agency Announcements or research solicitations on this topic. There is

no fee for attending the workshop, and DARPA will not provide cost reimbursement for workshop attendance.

Workshop participants are invited to brief their RFI responses. Due to limited time, presenters may be selected based upon details of their RFI responses, and time limits on the presentation will be determined based on a variety of factors including the number of presenters and the need to reserve time for other presentations and discussions. Presentations must be included with the RFI response and should not contain any proprietary data. In particular, all presentations submitted as a supplement to the RFI will be considered public information and will be made available to workshop attendees and, in the event of a BAA or other solicitation, on a public web site as well.

All materials presented at the ITMANET RFI Workshop must be approved in advance by both the organization that funded the research and the DARPA Program Manager. The DARPA Program Manager will screen the material for sensitive, but unclassified material. For this reason, any material you wish to present at the workshop must be received no later than March 1, 2006. It is the presenters' responsibility to ensure the material has been approved for public release by the organization that funded the research.

Workshop Point of Contact: All questions regarding the workshop should be sent to itmanet-workshop@darpa.mil.

II. Award Information

This notice, which constitutes the complete RFI package, is not a Request for Proposals (RFP), and is not to be construed as a commitment by the Government to issue a solicitation or ultimately award a contract. Responses will not be considered as proposals nor will any award be made as a result of this synopsis. The Government is not interested in specific company capability information and will not entertain such submissions. Any costs incurred as a result of responding to this announcement shall be borne by the respondent and cannot be charged to the Government for reimbursement.

III. Eligibility Information

1. Eligible Applicants

All responsible sources capable of satisfying the Government's needs may submit a position paper that shall be considered by DARPA.

2. Cost Sharing or Matching – N/A

IV. Application and Submission Information

1. Address to Request Application Package

This announcement contains all information required to submit a position paper. No additional forms, kits, or other materials are needed.

2. Content and Form of Application Submission

DARPA/IPTO requires completion of an online RFI Cover Sheet for each response, by accessing the URL below:

http://csc-ballston.dmeid.org/rfi/rfiindex.asp?RFIid=06-17

After finalizing the Cover Sheet Submission, the offeror must submit the Confirmation Sheet that will automatically appear on the web page. Each offeror is responsible for printing the Confirmation Sheet and submitting it attached to the original and each designated number of copies. The Confirmation Sheet should be the first page of your response. Failure to comply with these submission procedures may result in the position paper not being evaluated, and/or the submitter not being permitted to brief at the workshop.

Respondents must submit one original and two paper copies of the full response and two electronic copies of the full RFI response (in Microsoft Word or Adobe PDF on a single CD ROM). Disks must be clearly labeled with RFI 06-17, offeror organization, and points of contact. The full RFI response (original and designated number of hard and electronic copies) must be submitted to: DARPA/IPTO, Attn: RFI 06-17, 3701 N. Fairfax Drive, Arlington, VA 22203-1714.

Position papers are limited to 15 pages in length (not including cover sheet), and respondents are encouraged to be as succinct as possible while at the same time providing actionable insight. Each response should address the questions posed above and should comprise the following sections: Section I. Cover Page: This should be the confirmation sheet referred to above under Cover Sheet Submission. Section II. Details of submitted position on research in Information Theory for Mobile Ad-Hoc Networks (ITMANET), preferably organized in a question/answer format addressing the above questions and any others the submitter deems important. Section III. Additional Information: In addition to the required submission, respondents are encouraged to attach a brief list of key citations, including URLs if available. Respondents are also permitted to include a relevant paper and a PowerPoint or PDF presentation for the workshop if desired.

3. Submission Dates and Times
Submissions will be considered if they are received at DARPA by 4:00 PM (ET), March 1, 2006. DARPA will acknowledge receipt of submissions via email and assign control numbers that should be used in all further correspondence regarding the position papers.

4. Intergovernmental Review – N/A

5. Funding Restrictions - N/A

6. Other Submission Requirements – N/A

V. Application Review Information

1. Criteria – N/A

2. Review Process – N/A

VI. Award Information Administration – N/A

1. Award Notices – N/A

2. Administrative and National Policy Requirements – N/A

3. Reporting – N/A

VII. Agency Contacts
All administrative correspondence and questions concerning this announcement should be directed to one of the following administrative addresses:

Fax: 703-741-7804, Addressed to: DARPA/IPTO, Attn: RFI 06-17
Electronic Mail: itmanet-rfi@darpa.mil
Electronic File Retrieval: http://www.darpa.mil/ipto/Solicitations/solicitations.htm

Mail to: DARPA/IPTO
ATTN: RFI 06-17
3701 N. Fairfax Drive
Arlington, VA 22203-1714